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ABSTRACT

Some features of the American research university that might account for its success in facilitating research are suggested, and the philosophical foundations of the modern American research university and issues for the future are considered. The major universities of the United States have based their development during the 20th century on the principal that instruction and research belong together. There are roughly 100 research universities in the nation, and the faculties of these institutions have a major commitment to the performance of research and the training of new researchers. With the support of both internal resources and federal aid, the research universities account for the majority of the national output of basic research. The faculty researcher commonly comes to the university through a long selection process. Among the vital characteristics sought in that process, beginning in the undergraduate years, are intellectual power accompanied by independence, courage, honesty, and "taste," or the ability to choose from many possible paths. The research university commonly has a research structure that specifically appears similar to that of a business firm or a government agency. Future concerns are demographic changes, including the decreasing number of college-age persons, which will have effects on both the supply and demand sides. Other concerns are government regulation and direct intervention and the relationship between the research universities and other researcher environments, particularly industry. (SW)

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The American Research University

by

DONALD N. LANGENBERG

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In thinking about "nurturing environments for research," it is useful to look at research environments both here and abroad and to ask how they developed, how they function, how well they function, and what the future may hold for them. There are many types of research environment, each with its virtues and defects. This article discusses one particular type, the American research university. This is a unique institution, one which by most measures has been phenomenally successful. It is also an institution that is currently being strained by a variety of economic and demographic pressures; some fear it may be an endangered species. Because many believe it is important to the national welfare that research universities survive and, hopefully, flourish, it is necessary to understand their past and present and to consider what actions may be necessary to assure their future.

Past and Present

The philosophical foundations of the modern American research university are rooted in two quite different traditions. The oldest is that of the medieval monastery with its community of clerics, dedicated to the preservation of existing knowledge and its transmission to a select few among succeeding generations, gentlemen of rank and learned apprentice clerics. Such students remained the clientele of the early universities of Europe as they developed around small groups of scholar-clerics in such places as Oxford, Paris, and Bologna.

By the time of the American Revolution, the high value placed on learning in the colonies was reflected in the existence there of nine colleges, more than existed in all of Great Britain. Of these, one (Franklin's College of Philadelphia, later the University of Pennsylvania) was nonsectarian and the others were church-related. American colleges and universities largely remained faithful to their British models until well into the 19th century. Then began the emergence of the great state universities, a development fostered and accelerated by congressional passage of the Morrill (Land Grant) Act in 1862.

The second (much younger) tradition is that of the university as the home of research as well as scholarship, the quest for new knowledge as well as preservation and transmission of the old. This tradition developed first in Germany, where von Humboldt at Berlin planted the seeds of an evolution which spread rapidly through the German states and crossed the Atlantic with the founding of Johns Hopkins in 1867 as America's first university explicitly committed to research and advanced study.

The marriage of these two traditions, like most marriages, has not been free from real and imagined incompatibilities, right up to the present. Nevertheless, the major universities of this nation have based their development during the 20th century on the principle that instruction and research belong together, each enhancing the other in the hands and minds of faculty and students. In each institution this marriage of instruction and research had evolved differently. Today there exists in the same state, for example, the small independent California Institute of Technology with 1,600 students and the giant public University of California with 200,000 students on nine campuses. Despite their many differences, both institutions are world-renowned centers of learning and research. In such diversity many see a major source of national strength. The present result of a century of development of the modern American research university is a remarkably large and diverse group of institutions that together are unmatched anywhere in the world and that increasingly are used as models for university development in other countries.

What are the dimensions of the community of American research universities? There are several thousand institutions of higher education in the United States. Of these, roughly 100 might reasonably be termed research universities. The faculties of these institutions have a major commitment to the performance of research and the training of new researchers, supported by the institutions from their own resources and by the federal government. A little over 10 percent of total federal expenditures for research and development (R&D) and about half of the federal basic research budget go to universities. The latter amounts to about $3 billion in the current year. Perhaps one-quarter of the total institutional budget of a typical research university represents funds for sponsored research.

What do the research universities accomplish with these resources? They account for the majority of the national output of basic research at the frontiers of knowledge. A recent

study has shown that university scientists were responsible for more than 70 percent of the significant advances of the last 20 years in physics, chemistry, astronomy, and the earth sciences. Another found that 75 percent of the research reports in 13 fields came from scientists and engineers in universities. All but a few of the Nobel prizes awarded to Americans since World War II (a period during which Americans have dominated the Stockholm stage) have gone to academic scientists. Concepts like "efficiency," "cost/benefit ratio," or "productivity" are notoriously difficult to apply to basic research, but it is clear that the American research university is an extraordinarily effective research performer, truly a nurturing environment for research.

What makes it so? It is not easy to answer this question. The great diversity of research universities has already been noted. This essential lack of uniformity makes it impossible to describe how such an institution functions in a way that is completely general. Nevertheless, the major research universities share certain common features. It should be borne in mind that an over-simplified and idealized system is being described, to which many exceptions may be found.

The key element of the research university is the faculty researcher. The faculty researcher commonly comes to the university through a long selection process, one which is tedious, cumbersome, often rather cruel, and designed for survival of the fittest. It begins in the undergraduate years, where academic performance indicative of promise for graduate study and research must exist. Selection for admission to graduate study leads to further advanced academic work and then to the central essential feature of graduate training, the performance of a piece of original and significant research under the guidance of a faculty supervisor. There often follow several years of postdoctoral training during which the researcher can broaden and deepen his or her research skills and further demonstrate an ability to function as an independent and innovative explorer.

Those who choose and are chosen to enter academic careers then undergo a trial period (typically seven years or fewer) during which they are expected to demonstrate research achievement sufficient to establish a national or even international reputation among their professional peers. Those who rank highest in the estimation of their peers are granted lifetime tenure of position, a status that carries with it the commitment to a career of inquiry and exploration and the freedom to do so with none but the most minimal and essential constraints.

Among the vital characteristics sought in this long selection process are intellectual power accompanied by independence, courage, honesty, and what for want of a better word is often called "taste." Intellectual power is essential, for the realm of the unknown is complex and unyielding to those without knowledge and the ability to use it. Independence and courage are important, for the paths to new insights and understanding are rarely those which have been trod by others. Research is often a lonely and frustrating endeavor, with uncertainty and failure constant companions. Honesty, too, is important, for to deceive oneself or others about the facts and realities one uncovers is to assure failure in the long run if not the short. Finally, "taste," the mysterious ability to choose from the many possible paths before one those most likely to lead to an unseen revelation, is a rare and highly prized characteristic essential to the highest achievements in research.

The emphasis placed on these individual characteristics in the process of selecting senior members of the faculty of a research university suggests why the process leads to an institution with characteristics quite unlike that of most other institutions in society. One of the most obvious (and also most widely misunderstood) of these is organization or governance. A research university will commonly have an organizational structure that superficially appears similar to that of a business firm or a government agency. There will be an organization chart which shows some kind of board at the top, with a president, chancellor, provost, vice presidents, deans, department chairpersons, directors, etc., arranged in descending order, with the faculty at the bottom. But to understand the behavior of a research university it is essential to understand that such an organization chart is inverted in important respects.

The administrators of a research university do not in fact manage, control, or initiate the performance of research. These functions are the prerogative and responsibility of the faculty researcher. The role of an administrator is to facilitate and to help provide the necessary environment and resources for the research and instructional functions of the faculty, while interfering as little as possible with its freedom of action. In an institution that is working well, faculty and administration work together toward their common objectives. When differences arise, discussion and exchange of information and views through a system of collegial governance are relied upon to resolve the differences. If this fails and confrontation occurs, more often than not the faculty will prevail; senior faculty members have tenure, administrators do not.

Such a system will appear utterly illogical to many reasonable people, familiar with the hierarchical organizations of most societal institutions. It is untidy, disorderly, clumsy, and often anarchical. But centuries of experience show that only in such a system can the freedom essential to high performance in both instruction and research be maintained. Only in such an environment can those few who have the capacity to push forward the frontiers of knowledge function to the limits of their capabilities.

This article has tried to suggest some features of the American research university that might account for its success as a nuturing environment for research. Four key factors have been more eloquently identified and summarized by William Bowen, president of Princeton University, in his 1979 Presidential Report: "First, universities are committed to the twin concepts of academic freedom and the pursuit of the most fundamental questions, however unsettling or controversial they may be." This provides "an environment where original research can be conducted without the pressures of an immediate judgment about its significance." Second, "both the processes of the university (which are decentralized and heavily dependent on the judgment of peers) and the qualities that tend to motivate faculty members in their scholarship and research (including intellectual curiosity and independence) encourage a considerable degree of objectivity." Third, "Another characteristic of universities is that they encompass work in a great variety of disciplines." Fourth, "universities are special because of the interrelationships between research and teaching which is as important as it is evident." "What this means, in part, is that the investment in university research produces a double benefit: Not only is

the research accomplished in an unusually conducive environment, but those who will be the research leaders of the next generation are prepared and encouraged at the same time."

The Future

The article has described a kind of institution that the author thinks is unique. He has probably given the impression that it is healthy and vigorous. To a considerable degree, that is true. In the author's own field (physics), for example, there are no signs of a decrease in vitality. There are ample signs of serious competition from sources that were not major contenders 10 or 20 years ago; Germany and Japan, for example. But the author has no real worry that America lacks the institutions and the resources to meet that competition.

There are, however, some storm clouds on the horizon, and more overhead. Perhaps the most important problem research universities face is how to cope with the consequences of certain demographic trends. For the remaining two decades in this century the number of college-age persons will decrease, beginning right about now, reach a minimum somewhere around the end of the 1980s, rise a little bit, fall to an even deeper minimum in the early 1990s and then turn up. That has obvious implications for universities, including the possibility of damaging effects on their research capabilities. Fewer undergraduates will mean fewer people in graduate schools, fewer young researchers, and fewer young professors. Furthermore, because in many universities the number of faculty positions is tied intimately to the number of students, the number of positions available for young faculty will be few. This problem is exacerbated by the fact that the great expansion of university faculties in the 1950s and 1960s led to the presence on our faculties today of a large group of people in their 40s and early 50s who are not going to retire for another 20 years or so.

These demographic changes will have effects on both the supply and demand sides. Although there has been a lot of recent handwringing in academe over shortages of faculty positions for a surplus of available candidates, it is not at all clear whether this phenomenon or its *inverse* will be the major problem in maintaining research vitality in universities! Real shortages of able and willing candidates for junior faculty positions have existed in engineering schools for some years, and appear to be occurring now in some basic science fields. The only safe prediction one can make about the effects of demographic trends on research universities during the remainder of this century is that they will exist. Their magnitude and even size are highly uncertain. It does seem clear that these trends will require serious and continuing attention from those responsible for the health of research in universities, both in the universities and in governments. The effects on research universities will be both less severe and of a different nature than the effects on other institutions of higher education. But, to misquote a well known aphorism, "The price of survival is eternal vigilance."

Another problem deeply concerning many researchers might be characterized by the term "government pressures," which might include demands for greater accountability, more regulation and, some would say, direct intervention in the internal affairs of the research universities, both public and independent. It is not possible to go back to the "good old days" when the federal government took little interest in universities. That is impossible partly because the research universities have simply been too effective at serving the public interest through research. They are now absorbing quite visible amounts of the taxpayers' dollars, and this visibility is leading to demands for greater accountability for use of those funds and for a generally tighter coupling between the federal government and the research universities. Some of this is both desirable and inevitable. But, if one believes, as the author does, that the success of universities in creating a nurturing environment for research has in large part been a consequence of their queer, untidy, and anachronistic ways of doing things, then one must concede that a proper balance must be struck in the partnership between the government and the universities lest the characteristics of the universities that have made them function so well be destroyed.

Many of the problems that exist in the relationship between the federal government and the research universities are due to lack of communication and lack of understanding on both sides. The research enterprise has become so large that on the federal side there are more and more officials who are not of the type that were in the research sponsoring and managing game early on; that is to say, people who had come out of the research universities or who had been active scientists. Such people usually had knowledge and a good intuitive feel for how a research university really works. To many of the new breed of federal research officials, a research university seems to look like just another arena in which to apply "sound management practices," much like a pretzel factory or a government bureau. On the university side, many faculty researchers and even administrators have come to take for granted the flow of federal research funds without having developed any appreciation of the political constraints under which the government must operate or of the obligations that accompany the funds.

It is very difficult to explain a research university to someone who knows a little about how one works. It is nearly impossible to explain it to someone who knows almost nothing about it. It is equally impossible to explain to a faculty researcher why he or she must write a report or fill out a form now and then, when all the researcher is doing is spending a few hundred thousand dollars of the taxpayers' money in a good cause and wants to be left alone to do it. Nevertheless, one must find ways to improve the quality and quantity of consultation and information exchange between the government and the research universities. There are mechanisms for this purpose in place; e.g., the educational associations housed at One Dupont Circle in Washington, D.C. They are doing a pretty good job without much in the way of resources. But one must find ways to use the available mechanisms more effectively and do a lot more thinking about opening alternative channels of communication. The relationship between the federal government and the research universities has become unpleasantly adversarial in recent years, and if the bickering is not cut out, one of the most fruitful partnerships around will be ruined.

Another thing to worry about is the increasing cost of research. The cost of research is increasing partly because the amount of research performed and the number of people involved has increased. Reseach institutions wanted such an increase. They said they had to increase for the national welfare and security. Lots of researchers were trained. Now they are out there doing research, and they need supplies and equipment and staff support, so up go re-

search costs. Research costs are of course also going up because of inflation, like everything else. And there's a third reason: costs are increasing because research is getting more complicated to do. The necessary equipment and facilities are larger and more sophisticated than in the past.

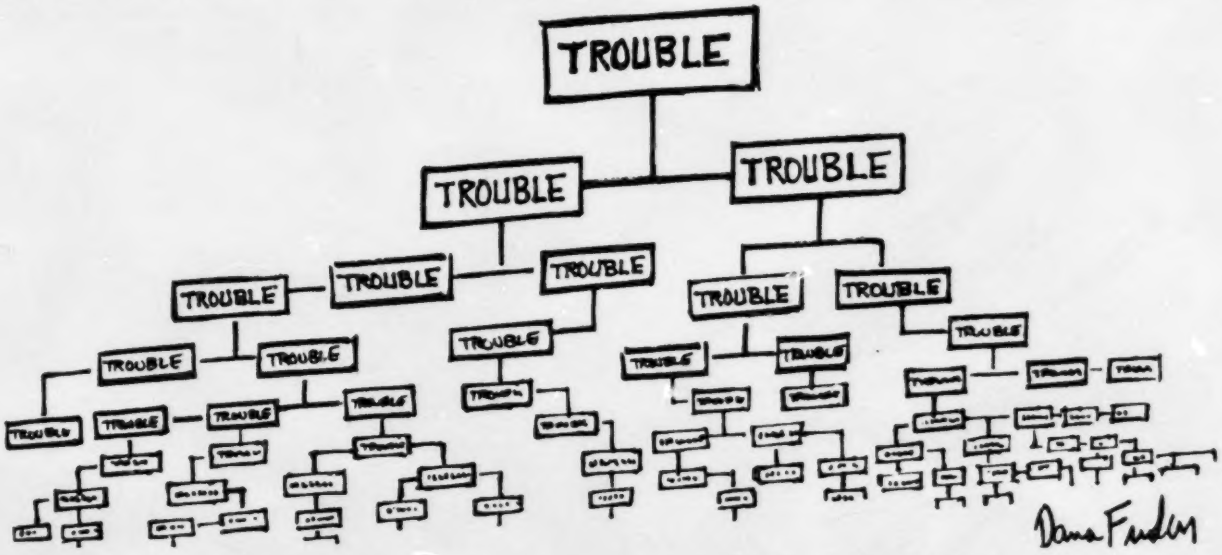
More and more national laboratories, national centers, regional centers, and large facilities of all kinds are being developed. It is no longer just the high energy physicists with their accelerators. The materials scientists, the condensed matter physicists, the chemists, and the biologists need large computers, synchrotron light sources, and nuclear reactors for neutron scattering experiments. This trend is going to continue and expand throughout the natural sciences. That prospect raises some questions. There is the obvious one about how to stretch dollars for maximum benefit. But since this article is about a particular kind of nurturing environment for research, it will focus on some other questions: If one must do big science with big facilities because that is the only way to attack some major scientific problems, what part will the research universities play in doing this kind of science?

Recognizing that one of the traditional modes of university research has involved the single researcher with a student or two, a lab with a couple of benches, some simple equipment, some sealing wax and string, and a few dollars, what does the spread of "big science" portend for the future of the research universities? This is not to imply that the trend toward "big science" is something to be strenuously resisted. In many fields, massive facilities are simply essential to accomplish anything at all. One cannot do oceanographic research on the high seas in a rowboat. However, this trend will change the life styles of many academic scientists and therefore the nature of their institutions. This happened long ago in high energy physics, and those in that field have developed ways of coping with their situation that deserve careful study by those only now contemplating doing "big science." Researchers need also to become more aware of the potential effects of the trend toward "big science" in some fields and to take them into account as we guide our research universities into their uncertain futures.

Finally, another issue that is beginning to attract a good deal of deserved attention is the relationship between the research universities and other research environments, particularly industry. Once upon a time there were rather extensive interrelationships in matters of research between industry and the universities, but with the rise of federal support for research in universities after World War II the federal government became the major actor and industry essentially dropped out. It might be time to think about rebuilding the industry-university relationship, recasting it, and creating a three-member partnership. There are some signs that the industry-university connection is being revived. The federal government has recently started to actively encourage and support such developments. The appearance of another partner in the existing government-university relationship will undoubtedly make an already complex situation even more complex, but it will also open up some badly needed avenues to more effective performance in the overall national research effort.

Summary

Among the many types of environment that have been devised to nurture research is the American research university. It differs significantly in character and organization from other such environments, but has proven itself extraordinarily effective in the performance of basic research and the training of young researchers. It is today a vigorous and vital institution. It is not without its problems, and more loom ahead, as demographic trends, economic stringencies, increasing government involvement, and changes in the style of research subject it to rapidly changing forces. It will surely change in response to these forces, indeed it must change. But with wise leadership, a little help from its friends, and luck, it will change for the better, maintaining its strengths and reducing its weaknesses. ♦



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